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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HONGYU YUE
and WESLEY NATZLE

Appeal 2008-2759
Application 10/817,417
Technology Center 1700

Decided: July 31, 2008

Before BRADLEY R. GARRIS, CHARLES F. WARREN, and ROMULO H. DELMENDO, *Administrative Patent Judges*.

WARREN, *Administrative Patent Judge*.

DECISION ON APPEAL

Applicants appeal to the Board from the decision of the Primary Examiner finally rejecting claims 1 through 6, 8, and 9 in the Office Action mailed June 20, 2006. Claim 8 was subsequently cancelled in the Amendment filed December 22, 2006, that was entered in the Office Action mailed December 6, 2007, leaving claims 1 through 6, and 9 for

consideration. 35 U.S.C. §§ 6 and 134(a) (2002); 37 C.F.R. § 41.31(a) (2005).

We affirm the decision of the Primary Examiner.

Claim 1 illustrates Appellants' invention of a method for achieving a target trim amount of a feature on a substrate in a chemical oxide removal process, and is representative of the claims on appeal:

1. A method for achieving a target trim amount of a feature on a substrate in a chemical oxide removal process comprising:

acquiring trim amount data as a function of time for a process recipe;

determining a relationship between a value related to said trim amount data and time;

using said target trim amount and said relationship to determine a target trim time for achieving said target trim amount;

chemically treating said feature on said substrate by exposing said substrate using said process recipe for said target trim time; and

substantially removing said trim target amount from said feature, wherein said determining includes fitting said trim amount data as said function of time with a log relationship of the form $x = L\ In(t) + L\ In\ (C/L)$, wherein x represents trim amount data, t represents time, and L and C are constants for said process recipe.

The Examiner relies upon the evidence in these references (Ans. 3):

Natzle	US 2004/0097047 A1	May 20, 2004
Tomoyasu	US 2004/0185583 A1	Sep. 23, 2004
Doris	US 2004/0241981 A1	Dec. 2, 2004

Harrison M. Wadsworth, Jr. (Wadsworth), "Nonlinear Regression," *Handbook of Statistical Methods for Engineers and Scientists* 18.1-18.5 (Second Ed. New York. McGraw-Hill. 1998).

Appellants request review of the following grounds of rejection under 35 U.S.C. § 103(a) advanced on appeal (Br. 8[1]):

claims 1 through 6, and 9 over Tomoyasu in view of Wadsworth (Ans. 3); claim 1, 4 through 6, and 9 over Natzle in view of Wadsworth (Ans. 4); and claim 2 and 3 over Natzle as applied to claim 1 in view of Doris (Ans. 6).

Appellants argue the claims in each ground of rejection as a group. Br. in entirety. Thus, we decide this appeal based on claims 1 and 2. 37 C.F.R. § 41.37(c)(1)(vii) (2005).

The issues in this appeal are whether the Examiner has carried the burden of establishing a prima facie case in each of the grounds of rejection advanced on appeal.

The plain language of claim 1 specifies a method comprising at least the steps, *inter alia*, acquiring trim amount data a function of time for any chemical oxide removal (COR) process recipe, determining any relationship between any value based on any parameter of the recipe related to the trim amount data and time, and fitting the trim amount data as a function of time with a log relationship of the form $x = L\ In(t) + L\ In\ (C/L)$, wherein x represents trim amount data, t represents time, and L and C are constants for two parameters of the process recipe. *See* Spec., e.g., 25-26 and Figs. 16-18. The target trim amount and the fitted relationship are used to determine a target trim time to achieve the target trim amount in applying the COR recipe to any feature of any substrate.

We find Tomoyasu would have disclosed to one of ordinary skill in this art a method of operating a COR processing system which includes,

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[1] We have numbered the pages of the Brief filed December 26, 2006,

inter alia, "performing at least one of setting, monitoring, and adjusting one or more chemical process parameters" for the system comprising "at least one of a chemical treatment processing pressure, . . . [a system component] temperature, and a chemical treatment gas flow rate; [and] processing the substrate . . . using the one or more chemical process parameters." Tomoyasu, Abstract and ¶ 0007; *see also* ¶¶ 0055-0056 and 0059. The system includes a COR module in which the COR reaction product is formed and a post heat treatment chamber in which the reaction product is evaporated. Tomoyasu, e.g., ¶¶ 0052, 0057-0058, and 0061.

The COR processing system has a number of components which provide process targets, recipe parameters, data gathering and analysis, including algorithms, and adjustment of the COR recipe applied to the substrate. Tomoyasu, e.g., ¶¶ 0029-0054 and 0075-00127, and Figs. 1-5. The system components establish the initial state of the wafer and the target state of the wafer with respect to critical dimensions, and uses the difference to "predict, select, or calculate a set of process parameters to achieve the desired result" with respect to that dimension. Tomoyasu ¶¶ 0063-0069 and 0085.

The system components "can compute a predicted state for the wafer based on the input state, the process characteristics, and a process model," including "a trim rate model [that] can be used along with a processing time to compute a predicted trim amount" and "an etch rate model can be used along with a processing time to compute an etch depth," using a number of models. Tomoyasu ¶¶ 0072-0074; *see also* ¶ 0062. The system components

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beginning with the title page.

use "measured actual process results . . . compared with the predicted process results in order to determine a correction to the process model," as well as "[m]odel updates . . . by running monitor wafers, varying the process settings and observing the results" to update models. Tomoyasu ¶¶ 0077-0080.

Tomoyasu discloses an embodiment in which the COR recipe includes "a process gas comprising HF [(hydrogen fluoride)] and NH_3" (ammonia), a processing pressure, gas flow rates, and system component temperature. Tomoyasu ¶¶ 0059-0060. The system includes a "process model [that] not only provides input parameters for gas flow rates but also provides input parameters for gas flow rate ratio." Tomoyasu ¶ 0088. Tomoyasu illustrates chemical treatment system 1220 as including "delivery of a heat transfer gas . . . to the backside of substrate 1242 via a backside delivery system," wherein "the heat transfer gas . . . can comprise an inert gas such as helium [(He)], argon [(Ar)], . . . a process gas such as CF_4, . . . , or other gas such as oxygen, nitrogen, or hydrogen." Tomoyasu ¶ 0195 and Figs. 15 and 16. Tomoyasu further illustrates chemical treatment system 1220 as including "a gas distribution system 1260 for distributing a process gas comprising at least two gases," wherein "[t]he process gas can, for example, comprise NH_3, HF, H_2, O_2, CO_2, Ar, He, etc." Tomoyasu ¶ 0200 and Figs. 15, 16, and 18.

We find Natzle would have disclosed to one of ordinary skill in this art a process of making MOSFET devices which includes a COR precleaning step that employs vapors of HF and NH_3 as reactants to form a COR adsorbed reactant film under low pressure on silicon oxide as a self-

limiting etch to strip the silicon oxide from a substrate, wherein the gas flow is controlled by valves and an exhaust pump. Natzle, e.g., Abstract and ¶¶ 0002, 0014, and 0037-0038. The COR adsorbed reactant film remains on the substrate surface while the vapor pressure of NH_3 and HF is near the vapor pressure at the temperature of the apparatus, and a reaction product comprising ammonium hexafluorosilicate ($(NH_4)_2SiF_6$) is formed under the reactant film. Natzle, e.g., ¶¶ 0039-0042. The reaction product can be removed by evaporation in a heated chamber. Natzle, e.g., ¶ 0046.

The amount of silicon oxide removed from the substrate "is a function of the substrate temperature, composition and residence time of the adsorbed reactant film," and "[f]actors influencing the amount removed per unit time include the vapor pressure of the reactant at the temperature of the substrate . . . ; the amount of reactant or the rate of reactant admitted to the COR chamber . . . ; the speed of [the vacuum] pump . . . ; and the reaction rate between the adsorbed reactant film . . . and the . . . .silicon oxide layer," all of which can be regulated. Natzle, e.g., ¶ 0042-45. "The self-limiting thickness [of the adsorbed layer] can be tuned by changing the reaction conditions," including pressure, temperature in the reaction chamber, and the amount and mixture of reactive gases, each of which is controlled by separate feed lines. Natzle, e.g., ¶¶ 0047-0051 and 0106-0113.

We find Doris would have disclosed to one of ordinary skill in this art a COR process wherein a mixture of HF and NH_3 forms a solid reaction product with silicon oxide that can be removed by evaporation and rinsing the structure in water. Doris ¶¶ 0045-46.

We find Wadsworth would have disclosed to one of ordinary skill in this art statistical methods for analyzing data based on engineering and scientific principles, including curve fitting data using logarithmic-based statistical relationships.

We determine the Examiner has made out a prima facie case of obviousness with respect to each of the grounds of rejection based on the Examiner's findings from the applied references and the conclusions based thereon as set forth in the Answer (Ans. in entirety), and remain of that opinion upon reconsideration of the record as a whole in light of Appellants' contentions. We add the following to the Examiner's position for emphasis.

Considering first the ground of rejection of claim 1 over the combined teachings of Tomoyasu and Wadsworth, the Examine concludes the teachings of Tomoyasu would have led one of ordinary skill in this art to acquire trim amount data based on a COR recipe as a function of time and to determine a relationship between parameters of the recipe and time. Ans. 3-4. The Examiner further concludes it would have been obvious to this person from Tomoyasu's use of analytical tools to use common engineering and statistical methods known in the art including curve fitting techniques based on experimental data in log or exponent relationships, as evinced by Wadsworth, to determine and cure fit the relationship between trim amount and trim time. Ans. 4 and 6-7.

Appellants submit Tomoyasu does not teach or suggest "fitting the trim amount data as a function of time with a log relationship of the form $x = L\ In(t) + L\ In\ (C/L)$" as claimed. Br. 10. Appellants contend that Wadsworth is directed to statistical modeling theory and identifies generic,

logarithmic-based statistical relationships, and thus also does not teach the claimed log relationship. Br. 10. Appellants contend Tomoyasu and Wadsworth do not suggest that Tomoyasu's trim rate model could be modified to achieve the claimed fitting relationship as a result-effective variable and thus hindsight is involved in the Examiner's position. Br. 10-11.

We cannot agree with Appellants' position. One of ordinary skill in this art routinely following Tomoyasu's teachings would have used trim rate data for COR recipes employing such parameters as flow rates for two different reactant gases, to obtain trim rate models and would have used the models along with processing times to predict trim amounts. In doing so, this person would have had to acquire trim rate data based on the relationship of the trim rate achieved by holding recipe parameters constant over time.[2] We determine this person would have recognized that time is a result effective variable when applying a COR recipe with constant parameters to obtain a critical dimension of a substrate feature. Thus, as the Examiner concludes, this person would have reasonably applied common engineering and statistical methods known in the art, including curve fitting techniques based on experimental data in log or exponent relationships evinced by Wadsworth, to the trim rate models taught by Tomoyasu in the reasonable expectation of obtaining predictable results in determining a

[2] It is well settled that a reference stands for all of the specific teachings thereof as well as the inferences one of ordinary skill in this art would have reasonably been expected to draw therefrom, *see In re Fritch*, 972 F.2d 1260, 1264-65 (Fed. Cir. 1992); *In re Preda*, 401 F.2d 825, 826 (CCPA

target trim time for achieving a target trim amount in applying the COR recipe with constant parameters to a feature of a substrate.

Accordingly, on this record, we are of the opinion that the Examiner has established that, prima facie, one of ordinary skill in this art routinely following the combined teachings of Tomoyasu and Wadsworth would have reasonably arrived at the claimed method for achieving a target trim amount of a feature on a substrate in a COR process encompassed by claim 1 without resort to Appellants' Specification. *See, e.g., KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-41 (2007) *quoting In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) ("[A]nalysis [of whether the subject matter of a claim would have been obvious] need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ."); *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)(("[T]he test [for obviousness] is what the combined teachings of the references would have suggested to those of ordinary skill in the art."); *Sovish*, 769 F.2d at 743 (skill is presumed on the part of one of ordinary skill in the art); *In re Bozek*, 416 F.2d 1385, 1390 (CCPA 1969) ("Having established that this knowledge was in the art, the examiner could then properly rely, as put forth by the solicitor, on a conclusion of obviousness 'from common knowledge and common sense of the person of ordinary skill in the art without any specific hint or suggestion in a particular reference.'"); *see also In re O'Farrell*, 853 F.2d 894, 903-04 (Fed. Cir. 1988) ("For

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1968), presuming skill on the part of this person. *In re Sovish*, 769 F.2d 738, 743 (Fed. Cir. 1985).

obviousness under § 103, all that is required is a reasonable expectation of success." (citations omitted)). Indeed, contrary to Appellants' contentions, the Examiner established a prima facie case of obviousness with evidence establishing that one of ordinary skill in this art would have reasonably arrived at the claimed log relationship specified in claim 1 even though neither Tomoyasu nor Wadsworth specified that log relationship. *See, e.g.*, *KSR Int'l*, 127 S. Ct. at 1740-41.

Turning now to the ground of rejection of claim 1 over the combined teachings of Natzle and Wadsworth, the Examiner concludes the teachings of Natzle would have led one of ordinary skill in this art to acquire trim amount data based on a COR recipe as a function of time and to determine a relationship between parameters of the recipe and time, and use the same to determine a target rime time for achieving a target trim amount. Ans. 4-5. The Examiner further concludes it would have been obvious to this person to use common engineering and statistical methods known in the art including curve fitting techniques based on experimental data in log or exponent relationships, as evinced by Wadsworth, to determine and curve fit the relationship between trim amount and trim time taught by Natzle. Ans. 5 and 7-8.

Appellants "substantially rely on similar reasons to those presented" with respect to Tomoyasu and Wadsworth, pointing out that neither reference teaches the log relationship specified in claim 1 or that the claimed relationship is a result effective variable. Br. 11-12.

While we also remain of the opinion above, we emphasize here Natzle's teachings that the amount of silicon oxide removed per unit time

depends on such COR recipe parameters as the amount and flow of reactant gases which can be controlled. These teachings would have led one of ordinary skill to acquire trim rate data for a COR recipe based on the relationship of the trim rate achieved by holding recipe parameters constant over time, and thus to the recognition that time is a result effective variable in applying a COR recipe with constant parameters to obtain a critical dimension of a substrate feature. Thus, as the Examiner concludes, this person would have reasonably applied common engineering and statistical methods known in the art, including curve fitting techniques based on experimental data in log or exponent relationships evinced by Wadsworth, to Natzle's trim amount data as a function of time in the reasonable expectation of obtaining predictable results in determining a target trim time for achieving a target trim amount in applying the COR recipe with constant parameters to a feature of a substrate.

Accordingly, on this record, we are of the opinion that the Examiner has established that, prima facie, one of ordinary skill in this art routinely following the combined teachings of Natzle and Wadsworth would have reasonably arrived at the claimed method for achieving a target trim amount of a feature on a substrate in a COR process encompassed by claim 1 without resort to Appellants' Specification. *See, e.g., KSR Int'l*, 127 S. Ct. at 1740-41 (*quoting Kahn*, 441 F.3d at 988); *Keller*, 642 F.2d at 425; *Sovish*, 769 F.2d at 743; *Bozek*, 416 F.2d at 1390; *see also O'Farrell*, 853 F.2d at 903-04.

With respect to the ground of rejection of claim 2 over the combined teachings of Natzle and Doris, the Examiner relies on "modified Natzle" as

applied to claim 1 which thus includes reliance on Wadsworth as combined with Natzle even though not specifically stated in the statement of the present ground of rejection. Ans. 6. Thus, Appellants' contentions that neither Natzle nor Doris provides teachings which would suggest the log relationship specified in claim 1 (Br. 12-13) do not address the thrust of the Examiner's rejection applying Doris. Therefore, Appellant has not rebutted the Examiner's prima facie case of obviousness.

Accordingly, based on our consideration of the totality of the record before us, we have weighed the evidence of obviousness found in the combined teachings of Tomoyasu and Wadsworth, the combined teachings of Natzle and Wadsworth, and the combined teachings of Natzle and Doris, with Appellants' countervailing evidence of and argument for nonobviousness and conclude that the claimed invention encompassed by appealed claims 1 through 6 and 9 would have been obvious as a matter of law under 35 U.S.C. § 103(a).

The Primary Examiner's decision is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

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